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The Effect of Oral Rehydration Solutions (Sports Drinks) on Strength, Speed, and Endurance: A Field Study



Honors Thesis

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Department: School of Health and Sports Science

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Abstract

Research Objective: The specific objective of this study is to contrast three different oral rehydration solutions (sports drinks) during a prolonged exercise trial on muscular strength, speed, and endurance in healthy young adult males.

Methodology: Thirteen (13) healthy male subjects will participate in a 5-mile walk on an outdoor track carrying a 40-pound rucksack on three separate occasions while drinking one of three (3) oral rehydration solutions (sports drinks) at a rate of 250 mL every 15 minutes as recommended by the American College of Sports Medicine. All three trails will be performed outdoors and differences in environmental conditions accounted for by balancing all three treatment groups on each of three days of testing. The three sports drinks that will be used are CeraSport® (a rice-based carbohydrate/electrolyte drink), Gatorade® (a commercial carbohydrate/electrolyte drink), and Ultima® (a commercial electrolyte drink without carbohydrates). The subject's hydration status will be assessed pre- and post-exercise using changes in body weight, urine output, and temperature change. Muscular strength will be assessed following the 90 minutes of exercise with three sets of pushups to exhaustion. Sprint performance will be measured as the mean of three 40-yard dash trials, and finally, subjects will run a timed mile to assess endurance capacity.

Disclaimer

Funding to pay participants and drink samples were provided by CeraSport®. The blinding of the study prevented participants from knowing their treatment and there was no conflict of interests.

Dedication or Acknowledgements

Special Thanks to the University of Dayton for their labs, equipment, and fields for testing, Dr. Linderman for his patience, and the University of Dayton's Honor's Program in funding the research.



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Introduction

Dehydration has a major impact on cardiovascular performance, even when the water loss is mild. A 2% decline in body mass due to dehydration can cause increased cardiovascular strain and decreased physical and cognitive performance. To prevent this from occurring, oral rehydration programs are used to maintain fluid balance to offset the amount lost through sweat and maintain homeostasis which is normal physiological function. The American College of Sports Medicine (ACSM) recommends a 6% carbohydrate/electrolyte beverage during exercise in a hyperthermic environment. Carbohydrates provide fuel for the working muscle, electrolytes replace sodium loss, and fluid replacement supports cardiovascular function lost (8).

Preventing excessive dehydration and electrolyte balance is important for athletes and military personnel because it is vital to success in their field where hot, humid conditions are common. Because dehydration can lead quickly to decreased performance and hyperthermic injury, proper oral rehydration programs are developed for individuals, so they can perform at their physical peak. This rehydration program begins before physical activity begins and continues after physical activity ends until the fluid electrolyte deficiency is mitigated (10).

Research in rehydration programs has focused on glucose, sucrose, and fructose-based drinks, such as Gatorade®, because it is the most commercially available oral rehydration solution. Its main carbohydrate source is sucrose (9). When comparing glucose, fructose, and sucrose, in a study done on cyclists, peak carbohydrate oxidation was found with a combination of all three compared to an isocaloric amount of glucose. (4) Additionally, glucose combined with fructose (5) and glucose combined with sucrose (6) led to higher oxidation than glucose alone. All three studies demonstrated a peak in performance at an ingestion rate of 2.4 g/min.

CeraSport® is a Rice-Based Electrolyte drink that has shown to be more effective at replacing sweat losses during hot weather training than water (2). In studying the rate of stool output of people suffering from cholera, rice-solutions showed a significant

reduction of stool output of about 36% in adults and children. This data indicates an enhanced absorption of ions and helps prevent dehydration (3). In a recent study, Cera Sport® was shown to have faster gastric emptying rates of fluid and glucose, suggesting improved absorption along the gastrointestinal tract compared to other carbohydrate solutions (7).

Rehydration during endurance activities in hot and humid conditions is necessary for peak physical performance. For those who rely on their cardiovascular health to perform their jobs, such as athletes or military personnel, individual rehydration programs are being developed. Research lacks in the comparison of CeraSport®, a rice-based solution, and glucose/sucrose/fructose-based solutions. In the field, where physical performance is key, understanding the benefits and drawbacks of these solutions is vital.

CeraSport® is a rice-based electrolyte drink providing 40 kcals/8.45 fluid ounces (250 mL). Gatorade is a commercial carbohydrate/electrolyte drink containing 130 kcals/20 ounces (591 mL) using sucrose (table sugar) as its source of carbohydrate. Ultima® is an electrolyte drink which has no carbohydrates or calories. It was used as a control against the carbohydrate types.

Methods

Participants: The sample size of 13 subjects was used based upon the work of Azevedo and colleagues. These investigators recruited six (6) fit male subjects and reported significant differences in endurance capacity from sports drinks using high-intensity exercise lasting approximately 7 minutes in duration, preceded by 90 minutes of moderate intensity exercise. This protocol used twice the number of subjects with a similar 90 minutes of moderate exercise followed by a mile run for assessing endurance which lasted less than 11 minutes each. Participants were healthy between the ages of 20-29 and willing to participate in this study. They were within the 70th percentile VO2Max with less than 15% body fat. Data was analyzed from 9 participants who completed the protocol on all three days.

Protocol: The experiment was conducted on three separate days for each subject over a period of approximately 5 weeks.

Subjects were weighed, had their temperature taken, and ate a standard breakfast of 300 calories. Each was weighed in a pair of dry athletic shorts. Subjects then walked for 5.25 miles carrying a 40-pound ruck-sack around an outdoor track while consuming 250 mL of CeraSport®, Gatorade®, or Ultima® immediately prior to and every 15 minutes of exercise. Participants were blinded to what drink they were given. During the ruck, subject's heart rates were tracked with a Garmin watch to ensure moderate intensity. Each of the three treatments was represented equally on each of the testing sessions to account for differences in environmental conditions. Testing days were separated by a minimum of one week and treatment groups were assigned in order of arrival on the first day to minimize the effect of treatment order on measurement variability. The duration of the 5.25-mile walk was recorded and post-exercise body weight was measured. Subjects then underwent tests of strength, speed and endurance.

Strength was assessed using 3 sets of push-ups to exhaustion rotating between participants for rest time. The total of all three sets was recorded to assess muscular strength. Speed was assessed in subjects using 3 trials of a 40-yard dash. The average of three trials was recorded. Finally, subject's endurance was assessed with a timed mile and their performance recorded. After their last mile run, weight and temperature were recorded a final time. Urine output was recorded throughout the duration of the protocol to assess fluid balance as previously reported.

At the end of the protocol, participants took a survey with four questions and were asked to rank each with the following numerical values: 1 – strongly disagree, 2 – disagree, 3 – neither agree nor disagree, 4 – agree, 5 – strongly agree. The questions were (A) I enjoyed the taste of my sports drink. (B) My sports drink felt refreshing. (C) My sports drink provided me the energy I needed to complete the activities. (D) I believe my sports drink would improve my performance compared drinking just water.

Location: Baseline testing took place in the Human Performance Laboratory in College Park Center 220C and the experimental testing took place at the University of Dayton running track located off the main campus. Testing days took place mid-July to early-August. Each testing day a Wet Bulb Globe Thermometer will be used to assess WBGT temperature, roughly equivalent to the “feels like” temperature which accounts for humidity, wind, ambient temperature, and solar radiation. The WBGT will be recorded at the beginning of the day and every fifteen minutes thereafter.

Results

The Statistical data was run with a 1-Factor ANOVA in Microsoft excel with a p-value of 0.05. There was no statistical significance between any of the treatment groups, when comparing exercise, temperature, or fluid measurements. Two values showed statistical significance. One was the WBGT temperature between each day, with a p-value of $3.00\text{E-}05$. The temperature on the first day was $76.3(\pm 1.09)$. The temperature on the second day was $68.4 (\pm 1.67)$. The temperature on the third day was $76.5(\pm 3.21)$ (table 4).

The second set of values that showed a significant difference was the weight change, regardless of treatment group, from before the walk to after as compared to the change after the walk to completion of the protocol. The change in weight from pre to post ruck was $0.41 (\pm 0.77)$ lb. and the weight post to final was $-0.50 (\pm 1.23)$ lb. The p value was 0.008 (table 5 and graph 1)

The rest of the data on subject performance did not show a statistical significance (Table 1-3).

Discussion

The present study was modelled after that of Azevedo et al. In this study investigators utilized 90 minutes of exercise (~60%), followed by a time trial that was completed in ~7 minutes. Subjects in the present study completed the 5.25 mile walk in the range of 83-85 minutes, and the mean time for the mile run was ~ 7 minutes. However, this

study included both measures of strength and speed. Our data does not show any statistical significance with regard to completion of the walk, nor differences in strength, speed or endurance. One particular difference in the present study was that data was gathered en masse as a field study. While potentially more practical, uncontrollable psychological factors of competition between treatment groups may have affected results.

Although the WBGT temperature varied from test day to test day, the WBGT temperature was not particularly high and did not exceed 77 ° F. The change in temperature between days was expected and anticipated in a field study but did not seem to have an effect on the performance of the participants. Additionally, the hydration paradigm prevented loss in body mass in all trials. By the end of the tests for strength, speed, and endurance, subjects lost body mass, however, the loss in body mass never approached the 2% loss associated with decreased performance.

Future studies in the laboratory using controlled hyperthermic conditions may further insight as to the effect of carbohydrate composition on performance during exercise.

Conclusion

The present data suggest that prolonged exercise in a moderate environment has no effect on strength, speed, and endurance, when subjects are well hydrated, and under these conditions the source of carbohydrate in the sports drink does not affect performance.

Tables and Graphs

Exercise	Average CeraSport®	Average Gatorade®	Average Ultima®	P-Value
5 Mile Walk (min)	83.65 (± 4.97)	85.44 (± 4.33)	85.14 (4.44)	0.67
1 Mile Run (min)	6.91 (± 1.09)	6.87 (± 0.94)	7.07 (± 1.03)	0.10
40-yard dash (sec)	5.48 (± 0.43)	5.28 (± 0.40)	5.39(± 0.44)	0.81
Push-Up (peak)	56.56(± 9.44)	54.11 (± 13.71)	51.44 (± 13.51)	0.07
Push-up (total)	132 (± 31.50)	129 (± 38.49)	123 (± 23.35)	0.77

Table 1 – The results of exercise testing when compared by treatment group

Measurement	Average CeraSport®	Average Gatorade®	Average Ultima®	P-Value
Weight Change Pre to Post (lb)	0.40 (± 0.80)	0.70 (± 0.7)	0.90 (± 0.7)	0.26
Weight Change Post to Final (lb)	-0.40(± 0.90)	-0.30 (± 1.5)	-0.80(± 1.4)	0.66
Urine output (ml)	480.00 (± 388.3)	204.50 (± 224.9)	265.90 (± 379.2)	0.26
Fluid Balance	0.84 (± 0.70)	1.16 (± 0.70)	0.78 (± 0.90)	0.42
Temp Change (degrees Fahrenheit)	6.63 (± 12.5)	1.81 (± 3.15)	1.10 (± 3.56)	0.12

Table 2- The results of the weight and fluid measurements when compared by treatment group

Question	Average CeraSport®	Average Gatorade®	Average Ultima®	P-Value
Question A	3.50 (± 1.00)	3.75 (± 1.00)	3.25(± 0.97)	0.86
Question B	3.75 (± 0.43)	3.50 (± 0.71)	3.25 (± 0.66)	0.33
Question C	4.125 (± 0.33)	3.75 (± 0.66)	3.63 (± 0.48)	0.19
Question D	3.75 (± 0.43)	3.50 (± 0.87)	2.86 (± 0.93)	0.12

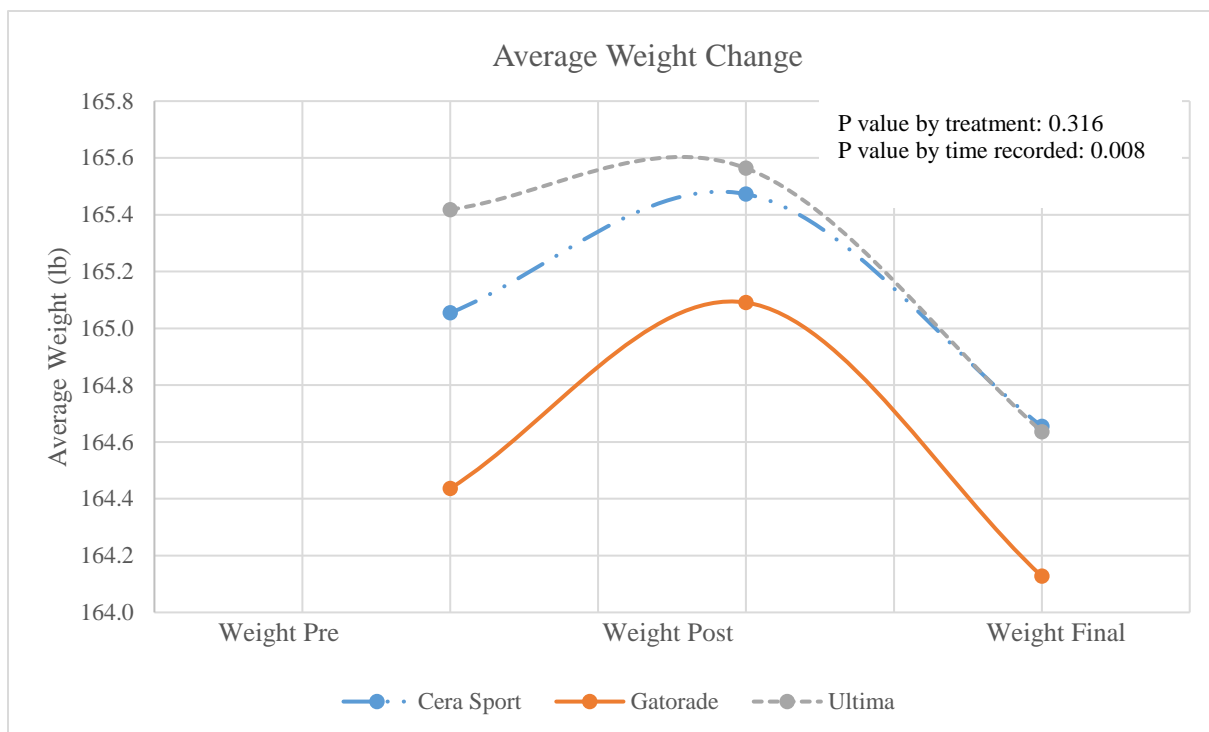
Table 3 – The results of the survey when compared by treatment group

	Day 1	Day 2	Day 3	P-Value
WBG (degrees Fahrenheit)	76.3(± 1.09)	68.4 (± 1.67)	76.5(± 3.21)	3.00E-05

Table 4- The temperature of the Wet Bulb Globe thermometer when compared by day

Weight Pre to Post (lb)	Weight Post to Final (lb)	P Value
0.41 (± 0.77)	-0.50 (± 1.23)	0.008

Table 5 – The change in body weight when compared by time recorded



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